

REMARKS

This responds to the Office Action mailed on December 21, 2004.

By this response, no claims are amended or added. Claim 40 was canceled. Claims 1-19 and 28-39 are now pending in this application. No new matter was added. Reconsideration of this application is requested in view of the above amendments and the following remarks.

§103 Rejection of the Claims

A. Rejection: Claims 1-5, 8-9, 12-14, 16, 18 -19, and 31- 40 were rejected under 35 USC § 103(a) as being unpatentable over Marlin (U.S. 6,429,046) in view of Paunovic et al. (U.S. 5,294,486).

B. Response: In order for the Examiner to establish a *prima facie* case of obviousness, three base criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference or references must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. *M.P.E.P.* § 2142 (citing *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed.Cir. 1991)).

The combination of Marlin, the admitted prior art (APA), and Paunovic et al. (U.S. 5,294,486) does not teach or suggest all the elements of claim 1. Marlin does not teach or suggest the element of a diffusion retarding layer for controlling the out-diffusion of the electrically conductive material from the at least one pad during a solder reflow process. The Marlin reference teaches a layer to prevent diffusion (See column 2, line 7 of the Marlin reference). Paunovic et al. also does not teach or suggest the element of a diffusion retarding layer for controlling the out-diffusion of the electrically conductive material from the at least one pad during a solder reflow process. More specifically, the Paunovic et al. reference teaches "...an improved barrier is provided in a stack 10 to keep atoms from a Cu conductivity layer 11

from diffusing into and affecting the properties of an Au corrosion inhibiting and solderability enhancing layer 12, effectively reducing the Cu present in the Au layer 12 after annealing for 2 hrs. at 400.degree. C. to about 0.2 to 0.44%. The improved barrier 13 is made up of three layers, an interlayer 14 of Au separated from the Cu layer 11 on one side by a layer 15 of Ni and separated from the Au layer on the other side by a layer 16 of Ni.” (See column 3, line 65 to column 4, line 8 of the Paunovic et al. reference). The Paunovic et al. reference teaches a three layer barrier that prevents movement of atoms within the film during an annealing process. In fact, the Paunovic et al. reference stresses the fact that the properties of the solderability layer 12 are to remain unchanged. Therefore, in the Paunovic et al. reference, the barrier is not for inhibiting diffusion between the solder ball and the film but to control diffusion within the film. The APA also does not teach or suggest the element of a diffusion retarding layer for controlling the out-diffusion of the electrically conductive material from the at least one pad during a solder reflow process. In fact, the APA also does not mention diffusion barriers and therefore does not supply this missing element. Therefore, at best, combining the diffusion barrier of Marlin, the barrier of Paunovic et al., and the APA yields a barrier that prevents diffusion within a film or stack rather than the diffusion retarding layer for controlling the out-diffusion of the electrically conductive material from the at least one pad during a solder reflow process. As a result, the combination of the Marlin reference, the APA, and the Paunovic et al. references relied upon by the Examiner fails to disclose each element as recited in claim 1. Accordingly, applicant believes that the Examiner’s rejection of claim 1 is overcome since the combination of Marlin reference, the APA, and the Paunovic et al. references fails to teach or suggest all the elements of claim 1.

Claims 2-5, 8, 9, 12 and 13 depend, either directly, or from claim 1 and include the limitations of claim 1 by their dependency. As a result, applicant believes that the Examiner’s rejection of claims 1-5, 8, 9, 12 and 13 are now also improper since the combination of the Marlin reference and the APA fails to show all the elements of each of these claims.

Claim 14 as now amended recites “...a diffusion retarding layer placed over the at least one pad...” As mentioned above, the diffusion layer of Marlin prevents diffusion rather than retarding diffusion. The barrier of Paunovic et al. also stresses the fact that the properties of the solderability layer 12 are to remain unchanged, thereby preventing diffusion within the stack.

Finally, the APA does not mention a diffusion barrier. Consequently, the combination of Marlin, the APA, and Paunovic et al. does not teach or suggest all the elements of claim 14.

Specifically, the combination of Marlin, the APA, and Paunovic et al. does not teach or suggest a diffusion retarding layer placed over the at least one pad

Claims 16, 18, and 19 depend directly from claim 14 and include the limitations of claim 14 by their dependency. As a result, applicant believes that the Examiner's rejection of claims 14, 16, 18, and 19 are now also improper since the combination of the Marlin reference and the APA fails to show all the elements of each of these claims.

Claim 31 recites "...means to retard diffusion of the copper associated with the copper pad adapted to retard the out-diffusion of the copper from the pad during a solder reflow process." As mentioned above, the diffusion layer of Marlin prevents diffusion rather than retarding diffusion. The APA does not mention a diffusion barrier. The Paunovic et al. reference teaches a three layer barrier that prevents movement of atoms within the film during an annealing process rather than "means to retard diffusion ...adapted to retard the out-diffusion of the copper from the pad during a solder reflow process ." (Claim 31) Consequently, the combination of Marlin and the APA and Paunovic et al. does not teach or suggest all the elements of claim 31.

Claims 32-34 depend directly from claim 31 and include the limitations of claim 31 by their dependency. As a result, applicant believes that the Examiner's rejection of claims 32-34 are now also improper since the combination of the Marlin reference and the APA fails to show all the elements of each of these claims.

Claim 35 recites "...means to retard diffusion of the copper associated with the copper pad ..." As mentioned above, the diffusion layer of Marlin prevents diffusion rather than retarding diffusion. The Paunovic et al. reference teaches a three layer barrier that prevents movement of atoms within the film during an annealing process. The APA does not mention a diffusion barrier. Consequently, the combination of Marlin and the APA does not teach or suggest all the elements of claim 31.

Claims 36-39 depend, either directly or indirectly, from claim 35 and include the limitations of claim 35 by their dependency. As a result, applicant believes that the Examiner's

rejection of claims 36-39 are now also improper since the combination of the Marlin reference and the APA fails to show all the elements of each of these claims.

Claim 40 was canceled by this amendment thereby making the rejection moot with respect to this claim. As a result, the rejection of claims 1-5, 8-9, 12-14, 16, 18 -19, and 31- 39 under 35 USC § 103(a) as being unpatentable over Marlin (U.S. 6,429,046) in view of Paunovic et al. (U.S. 5,294,486) is overcome.

C. Rejection: Claims 10 and 11 were rejected under 35 USC § 103(a) as being unpatentable over Marlin (U.S. 6,429,046), Paunovic et al. (U.S. 5,294,486) and APA as applied to claim 1 above, and further in view of Andricacos et al. (U.S. 6,224,690).

D. Response: Claims 10 and 11 depend indirectly from claim 1 and include the limitations of claim 1 by their dependency. As a result, applicant believes that the Examiner's rejection of claims 10 and 11 are now also improper since the combination of the Marlin reference, the Paunovic et al. reference, the APA, and the Andricacos et al. reference fails to show all the elements of each of these claims. Specifically, the combination of Marlin, Paunovic et al., the APA, and the Andricacos et al. reference does not teach or suggest a solder ball formed on at least one of the array of pads, at least one of the array of pads including a diffusion retarding layer for controlling the out-diffusion of the electrically conductive material from the at least one pad during a solder reflow process. Rather the combination of Marlin, Paunovic et al., the APA, and Andricacos et al. would result in a diffusion prevention barrier. There is no motivation in the references to modify the references to yield applicant's invention, as claimed. Furthermore, the fact that four references are combined to yield applicant's invention is evidence of the application of hindsight by the Examiner while using the applicants invention as a roadmap. As a result, the rejection of claims 10 and 11 under 35 USC § 103(a) as being unpatentable over Marlin (U.S. 6,429,046), Paunovic et al. (U.S. 5,294,486) and APA as applied to claim 1 above, and further in view of Andricacos et al. (U.S. 6,224,690) is overcome.

E. Rejection: Claims 6-7, 15, and 17 were rejected under 35 USC § 103(a) as being unpatentable over Marlin (U.S. 6,429,046), Paunovic et al. (U.S. 5,294,486) and APA as applied to claims 1 and 14 above, and further in view of Andricacos et al. (U.S. 6,224,690) and Okamoto et al. (U.S. 5,521,438).

F. Response: Claims 6 and 7 depend directly from claim 1 and include the limitations of claim 1 by their dependency. As a result, applicant believes that the Examiner's rejection of claims 6 and 7 are now also improper since the combination of the Marlin reference, the Paunovic et al. reference, the APA, the Andricacos et al. reference, and the Okamoto et al. reference fails to show all the elements of each of these claims. Specifically, the combination of Marlin, the Paunovic et al. reference, the APA, the Andricacos et al., and the Okamoto et al. reference does not teach or suggest a solder ball formed on at least one of the array of pads, at least one of the array of pads including a diffusion retarding layer for controlling the out-diffusion of the electrically conductive material from the at least one pad during a solder reflow process. The Okamoto et al. reference is directed toward joining a metallic member, such as an input/output terminal, by solder to a ceramic base by way of a stress layer (see abstract). The Examiner contends that the structure taught in the Okamoto et al. reference is for preventing further diffusion of an intermetallic, however, there is no mention of diffusion in the Okamoto et al. reference. At best the combination of Marlin, the Paunovic et al. reference, the APA, the Andricacos et al. reference would result in a diffusion prevention barrier and a stress relief portion. There is no motivation in the references to modify the references to yield applicant's invention, as claimed, to yield a diffusion retarding layer for controlling the out-diffusion of the electrically conductive material from the at least one pad during a solder reflow process.

Furthermore, the fact that five references are combined to yield applicant's invention is evidence of the application of hindsight by the Examiner while using the applicants invention as a roadmap.

In addition, applicant disagrees with the Examiner's statement that the "determination of parameters such as wt%/amount of various components, number of components, etc. in an alloy composition in chip packaging and interconnect technology art is a subject of routine experimentation and optimization to achieve the desired properties such as bonding strength,

adhesion, diffusion resistance, etc.” (page 7, penultimate paragraph of Office Action dated 12/21/04) Applicant requests that the Examiner place a reference in the file that indicates that this is truly “routine experimentation and optimization”. In the alternative, applicant requests that the Examiner place an affidavit of personal knowledge as to this routine experimentation and optimization.

Applicant also disagrees that one of ordinary skill in the art would find it obvious “to incorporate the diffusion retarding layer including Kovar or a composition 54Fe-29Ni-17Co as taught by Andricacos et al. and Okaomoto et al. so that the diffusion resistance and adhesion/bonding can be improved in Paunovic et al., APA and Marlin’s device.” (page 7, last paragraph of Office Action dated 12/21/04). The Okamoto et al. device appears to be directed toward other than diffusion barriers. Even though it discusses Kovar, one of ordinary skill in the art of diffusion barriers would not be disposed to looking at a reference dealing with joining a metallic member, such as an input/output terminal, by solder to a ceramic base by way of a stress layer (see abstract of Okamoto et al.).

Claims 15 and 17 depend directly from claim 14 and include the limitations of claim 14 by their dependency. As a result, applicant believes that the Examiner’s rejection of claims 15 and 17 are now also improper since the combination of the Marlin reference, the Paunovic et al. reference, the APA, the Andricacos et al. reference, and the Okamoto et al. reference fails to show all the elements of each of these claims. Specifically, the combination of Marlin, Paunovic et al., the APA, Andricacos et al., and the Okamoto et al. references do not teach or suggest a diffusion retarding layer placed over the at least one pad. The diffusion layer of Marlin prevents diffusion rather than retarding diffusion. The Paunovic et al. appears to do the same. The APA, Andicacos et al reference or the Okamoto et al reference does not mention a diffusion barrier. Consequently, the combination of the Marlin reference, the Paunovic et al. reference, the APA, the Andricacos et al. reference, and the Okamoto et al. reference fails to does not teach or suggest all the elements of claim 15 and claim 17.

As mentioned above, applicant disagrees that it would have been obvious to a person of ordinary skill in the art at the time the invention was made to incorporate the diffusion retarding layer including Kovar or a composition 54Fe-29Ni-17Co as taught by Andricacos et al. and Okamoto et al. so that diffusion resistance and adhesion/bonding can be improved in the APA

and Marlin's device. There is no basis in the art or stated by the Examiner that would lead one of ordinary skill to combine these references. As a result, the rejection of claims 6-7, 15, and 17 under 35 USC § 103(a) as being unpatentable over Marlin (U.S. 6,429,046), Paunovic et al. (U.S. 5,294,486) and APA as applied to claims 1 and 14 above, and further in view of Andricacos et al. (U.S. 6,224,690) and Okamoto et al. (U.S. 5,521,438) is overcome.

G. Rejection: Claims 28-30 were rejected under 35 USC § 103(a) as being unpatentable over Marlin (U.S. 6,429,046), Paunovic et al. (U.S. 5,294,486) and APA and as applied to claim 1, and further in view of Andricacos et al. (U.S. 6,224,690) and Simokawa et al. (U.S. 2002/0163085).

H. Response: "...a diffusion retarding layer placed on at least one of the array of pads; and solder placed on at least one of the array of pads, the solder and the pad including a intermetallic compound including Ni-Sn (Ni_3Sn_4) and Sn-Fe." The references cited do not teach or suggest the combination of a diffusion retarding layer and the specific intermetallic alloys recited in claim 28. Accordingly, claim 28 overcomes the Examiner's rejection under 35 USC 103(a). Claims 29 and 30 depend directly from claim 28 and add further limitations to the invention. As a result, claims 29 and 30 are also thought to overcome the Examiner's rejection.

Conclusion

Applicant respectfully submits that the claims are in condition for allowance and notification to that effect is earnestly requested. The Examiner is invited to telephone Applicant's attorney at (612) 373-6977 to facilitate prosecution of this application.

If necessary, please charge any additional fees or credit overpayment to Deposit Account No. 19-0743.

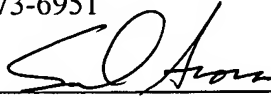
Respectfully submitted,

KUM FOO LEONG ET AL.

By their Representatives,

SCHWEGMAN, LUNDBERG, WOESSNER & KLUTH, P.A.
Attorneys for Intel Corporation
P.O. Box 2938
Minneapolis, Minnesota 55402
(612) 373-6951

Date February 22, 2004

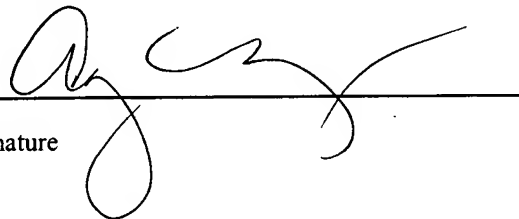
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Name

Amy Moriarty

Signature



AMENDMENT UNDER 37 C.F.R. 1.116 – EXPEDITED PROCEDURE

Serial Number: 10/673,605

Filing Date: September 29, 2003

Title: DIFFUSION BARRIER LAYER FOR LEAD FREE PACKAGE SUBSTRATE

Assignee: Intel Corporation

Page 2

Dkt: 884.A68US1 (INTEL)

IN THE DRAWINGS

Formal drawings are supplied herewith.